Claims

[c1] An electric actuator comprising:
a first plate;
a second plate substantially parallel to the first plate;
a linkage system that couples the first plate to the second plate such that moving the linkage system toward an over-center position causes the second plate to move away from the first plate;
an electric motor coupled to the linkage system, the electric motor capable of moving the linkage system toward the over-center position;
a force transducer coupled to the actuator, the force transducer capable of producing a force signal responsive to a force produced by the actuator;
a control system coupled to the electric motor and the force transducer, the control system capable of providing a control signal to the electric motor to move the linkage system to a position, the position being determined by the control system in response to the force signal.

[c2] The electric actuator of claim [c1], further including a screw coupled to the electric motor and to the linkage system, the electric motor capable of rotating the screw to move the linkage system.

[c3] The electric actuator of claim [c2] further comprising a threaded block that engages the screw such that the threaded block moves along the screw when the screw is rotated by the electric motor, the threaded block being coupled to the linkage system such that the linkage system moves toward the over-center position as the threaded block moves along the screw.

[c4] The electric actuator of claim [c3] wherein the linkage system further comprises:
a first link having a first end and an opposing second end, the first end pivotally connected to the second plate; and
a second link having a third end and an opposing fourth end, the third end pivotally connected to the second end of the first link.

[c5] a third link having a fifth end and an opposing sixth end, the fifth end pivotally connected to the fourth end of the second link, the sixth pivotally connected to the first plate; and

a lever arm rigidly connected to the fourth end of the second link and pivotally connected to the threaded block such that movement of the threaded block causes the one link to rotate and move the linkage system toward the over-center position.

[c6] The electric actuator of claim [c1], wherein the position determined by the control system is the position for a subsequent movement of the linkage system.

[c7] The electric actuator of claim [c1], wherein the position determined by the control system is determined after a plurality of movements of the linkage system.

[c8] The electric actuator of claim [c6], wherein the plurality of movements is three movements.

[c9] The electric actuator of claim [c6], wherein the force signal is the average of a plurality of forces produced during the plurality of movements.

[c10] The electric actuator of claim [c6], wherein the position is further responsive to a representative function for change of force versus change of end position.

[c11] The electric actuator of claim [c1], wherein the electric motor is a servo motor.

[c12] The electric actuator of claim [c1], wherein the electric motor is a stepper motor.

[c13] A heat seal station for heat sealing a plastic film comprising:
a platen;
a heat seal die;
an electric actuator having a first end coupled to the platen and an opposing second end coupled to the heat seal die;
a linkage system that couples the first end of the actuator to the second end such that moving the linkage system toward an over-center position causes the heat seal die to move toward the platen;
an electric motor coupled to the linkage system, the electric motor capable of moving the linkage system toward the over-center position;

a force transducer coupled to the actuator, the force transducer capable of producing a force signal responsive to a force produced by the actuator;
a control system coupled to the electric motor and the force transducer, the control system capable of providing a control signal to the electric motor to move the linkage system to a position, the position being determined by the control system in response to the force signal.

[c14] The heat seal station of claim [c12], further including a screw coupled to the electric motor and to the linkage system, the electric motor capable of rotating the screw to move the linkage system.

[c15] The heat seal station of claim [c13], further comprising a threaded block that engages the screw such that the threaded block moves along the screw when the screw is rotated by the electric motor, the threaded block being coupled to the linkage system such that the linkage system moves toward the over-center position as the threaded block moves along the screw.

[c16] The heat seal station of claim [c14], further comprising:
a first link having a first end and an opposing second end, the first end pivotally connected to the heat seal die; and
a second link having a third end and an opposing fourth end, the third end pivotally connected to the second end of the first link.

[c17] a third link having a fifth end and an opposing sixth end, the fifth end pivotally connected to the fourth end of the second link, the sixth pivotally connected to the platen; and
a lever arm rigidly connected to the fourth end of the second link and pivotally connected to the threaded block such that movement of the threaded block causes the one link to rotate and move the linkage system toward the over-center position.

[c18] The heat seal station of claim [c12], wherein the position determined by the control system is the position for a subsequent movement of the linkage system.

[c19] The electric actuator of claim [c12], wherein the position determined by the

control system is determined after a plurality of movements of the linkage system.

[c20] The electric actuator of claim [c17], wherein the plurality of movements is three movements.

[c21] The electric actuator of claim [c17], wherein wherein the force signal is the average of a plurality of forces produced during the plurality of movements.

[c22] The electric actuator of claim [c17], wherein the position is further responsive to a representative function for change of force versus change of end position.

[c23] The heat seal station of claim [c12], wherein the electric motor is a servo motor.

[c24] The heat seal station of claim [c12], wherein the electric motor is a stepper motor.

[c25] A method for producing a heat seal in a plastic film comprising:
providing a first signal to move an electric motor to a first end position and thereby move a linkage system toward an over-center position, the linkage system being coupled to a platen and a heat seal die such that moving the linkage system toward the over-center position causes the heat seal die to move toward the platen; and
receiving a second signal from a force transducer coupled to the actuator when the electric motor is at the first end position, the second signal responsive to a force produced by the actuator;
wherein the first end position is controlled to produce a desired force responsive to the second signal.

[c26] The method for producing a heat seal of claim [c23], further comprising rotating a screw coupled to the electric motor and to the linkage system to move the linkage system.

[c27] The method for producing a heat seal of claim [c24], further comprising rotating a lever arm by rotating the screw, the lever arm being pivotally connected to a threaded block that engages the screw, the lever arm being rigidly connected to one link of the linkage system at a pivot point such that

rotation of the lever arm causes the one link to rotate and move the linkage system toward the over-center position.

[c28] The method for producing a heat seal of claim [c23], further comprising determining a second end position for a subsequent movement of the linkage system as a correction to the first end position responsive to a difference between a desired force and the force generated by the actuator at the first end position.

[c29] The method for producing a heat seal of claim [c23], further comprising:
providing predetermined values for force as a function of motor position;
finding a first nominal motor position based on the predetermined values that corresponds to the force represented by the second signal;
finding a second nominal motor position based on the predetermined values that corresponds to a desired force; and
determining a second end position for a subsequent movement of the linkage system as a correction to the first end position based on a difference between the first and second nominal motor positions.

[c30] The method for producing a heat seal of claim [c23], wherein the first signal is a signal for a servo motor.

[c31] The method for producing a heat seal of claim [c23], wherein the first signal is a signal for a stepper motor.

[c32] The method for producing a heat seal of claim [c23], further comprising receiving a third signal when the plastic film has advanced to a predetermined position, the third signal indicating that the first signal should be provided, the predetermined position being such that the plastic film will be stopped before the heat seal die comes into contact with the plastic film.

[c33] A method for producing a heat seal in a plastic film comprising:
moving a heat seal die toward a platen a plurality of times by
providing a first signal to move an electric motor to a first end position and thereby move a linkage system toward an over-center position, the linkage system being coupled to the platen and the heat seal die such that moving the

linkage system toward the over-center position causes the heat seal die to move toward the platen, and

receiving a second signal from a force transducer coupled to the actuator when the electric motor is at the first end position, the second signal responsive to a force produced by the actuator;

storing a plurality of force values, each force value corresponding to the force produced by the actuator for one of the plurality of movements of the heat seal die;

computing a representative force value from the stored plurality of force values; and

computing a corrected end position responsive to a difference between the representative force value and a desired force value.

[c34] The method for producing a heat seal of claim [c31], wherein the plurality of movements is three movements.

[c35] The method for producing a heat seal of claim [c31], wherein computing the representative force value further comprises computing the average of the plurality of force values.

[c36] The method for producing a heat seal of claim [c31], wherein computing the corrected end position is further responsive to a representative function for change of force versus change of end position.